CS 596 Functional Programming and Design
Fall Semester, 2014
Doc 11 Map Zippers, Manipulating Functions
Oct 9, 2014

BST as Maps & Zippers

Zippers are defined for

- XML
- vectors
- seq

What about other structures?

```
{:left {:value 5 :left nil :right nil} :value 10 :right {:value 15 :left nil :right nil}}
```

Can define zippers on other types

Making New Zippers

(zipper branch? children make-node root)

branch?

One argument - node

Returns true if node can have children

children

One argument - node

Returns sequence of the node's children

make-node

Two arguments - Existing node, seq of children

Returns new node from the children

Root

Root of the structure

Zipper for BST as a map

```
{:left {:value 5 :left nil :right nil} :value 10 :right nil}
```

branch?

```
    map?
```

children

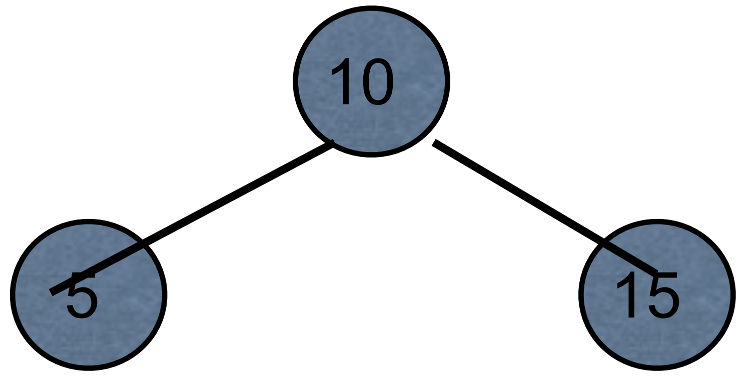
```
    (defn tree->children
      [map]
      [(:value map) (:left map) (:right map)])
```

make-node

```
    (defn children->tree
      [_ sequence]
      {:value (first sequence)
       :left (second sequence)
       :right (last sequence)})
```

Order has to match that in tree->children

Using the Zipper



```
(def map-tree {:left {:value 5 :left nil :right nil} :value 10 :right {:value 15 :left nil :right nil}})
```

```
(def map-zipper (zip/zipper map? tree->children children->tree map-tree))
```

```
(-> map-zipper
    zip/down
    zip/right
    zip/node)
```

```
{:value 5, :left nil, :right nil}
```

Doing insert in BST as map

```
(defn bst-map-insert
  [tree x]
  (bst-zipper-insert
    (zip/zipper map? tree->children children->tree tree)
    x))
```

Notice the repeat

```
(zip/zipper map? tree->children children->tree tree)
```

Once we figure out the needed functions would like to forget about it

```
(defn bst-map-zipper
   [tree-map]
     (zip/zipper map? tree->children children->tree tree-map)
```

Shorter Way - partial

```
(defn bst-map-zipper  (partial zip/zipper map? tree->children children->tree)
```

```
(partial f arg1 arg2 … argk)
```

f - function with n > k arguments
arg1 arg2 … argk - first k arguments of f
Return function that needs n - k arguments

Examples

```
(def hundred-times (partial * 100))
(hundred-times 5)                                           500

(hundred-times 5 4)                                         2000



(reduce + (take-while (partial > 1000) (iterate inc 0)))          499500



(def to-english (partial clojure.pprint/cl-format nil "~@(~@[~R~]~^ ~A.~)"))

(to-english 123456)

                  "One hundred twenty-three thousand, four hundred fifty-six"
```

Currying

Currying

Multi-argument function -> chain of single-argument functions

```
adder(a, b c) {a + b + c;}

addA = adder.curry();
addB = addA(2);
addC = addB(3);
answer = addC(4);
```

Manipulating Functions

juxt

Combines a set of functions
Returns vector applying each function to input

```
(def basic-math (juxt + - * /))
(basic-math 2 5)
```

```
[7 -3 10 2/5]
```

```
(def split-collection (juxt take drop))
(split-collection 4 (range 9))
```

```
[(0 1 2 3) (4 5 6 7 8)]
```

juxt in Sorting

```
((juxt :last :first) {:last "Adams" :first "Zak"} )                    ["Adams" "Zak"]


(sort-by (juxt :last :first) [{:last "Adams" :first "Zak"}             ({:last "Adams", :first "Zak"}
                              {:last "Zen" :first "Alan"}               {:last "Smith", :first "Alan"}
                              {:last "Smith" :first "Alan"}])           {:last "Zen", :first "Alan"})


(sort-by (juxt :first :last) [{:last "Adams" :first "Zak"}           ({:last "Smith", :first "Alan"}
                         {:last "Zen" :first "Alan"}                  {:last "Zen", :first "Alan"}
                         {:last "Smith" :first "Alan"}])              {:last "Adams", :first "Zak"})
```

comp

Takes a sequence of functions
Composes the functions

```
((comp str +) 8 8 8)                                "24"

(def fourth (comp first rest rest rest))
(fourth [:a :b :c :d :e])                            :d
```

sdsu-nth

Given n can we produce

(comp first rest rest rest … rest)

where we have n -1 rest's?

Yes We Can!

```
(defn fnth
  [n]
  (apply comp
        (cons first
              (take (dec n) (repeat rest)))))
```

```
((fnth 1) [:a :b :c :d :e])                    :a
((fnth 3) [:a :b :c :d :e])                    :c
```

Example from Joy of Clojure, Second Edition

How does this work?

`(repeat rest)`	infinite lazy sequence of rest
`(take (dec n) (repeat rest))`	`'(rest rest … rest)    ;n-1 rest's`
`(cons first (take (dec n) (repeat rest)))`	`'(first rest rest … rest)`
`(apply comp (cons first (take (dec n) (repeat rest))))`	`(comp first rest rest … rest)`

```
(repeat rest)

(take (dec n) (repeat rest))

(cons first
        (take (dec n) (repeat rest)))

(apply comp
        (cons first
              (take (dec n) (repeat rest))))
```

memoize

```
(memoize f)

      Caches results of function f
      Uses cached value next time f is called with same arguments

(defn adder
  [x]
  (println "adder" x)
  (inc x))

(def adder-memoized (memoize adder))

(adder-memoized 1)          prints 1, returns 2
(adder-memoized 1)          returns 2
(adder-memoized 2)          prints 2, returns 3
(adder-memoized 1)          returns 2
```

memoize - Cache Size

Cache is a map

Contains return values for each different set of input arguments

Delay

Suspends execution of code until delay is dereferenced

Caches result

Second time dereferenced returns cached result

Thread safe

```
(def wait (delay (println "do it now") (+ 1 2)))

 @wait                  prints "do it now", returns 3
 @wait                  returns 3
```

realized?

Returns true if a value has been produced for a promise, delay, future or lazy sequence.

```
(def wait (delay (println "do it now") (+ 1 2)))
```

```
(realized? wait)   false
@wait                  prints "do it now", returns 3
(realized? wait)   true
@wait                  returns 3
```

Example - Proxy for Expensive Operation

```
(defn fetch-page
  [url]
  {:url url
   :contents (delay (slurp url))})
```

```
(def result (fetch-page "http://www.eli.sdsu.edu/index.html"))

(:contents result)                  #<Delay@2fcc470c: :pending>

(realized? (:contents result))      false

@(:contents result)                 "<!DOCTYPE html>\n<html lang=\"en\">\n …"
```

@ and deref

```
@(:contents result)
```

```
(deref (:contents result))
```

They do the same thing

Future

Computes body on another thread

Use @ or deref to get answer

@, deref blocks until computation is done

```
(def long-calculation (future (apply + (range 1e8))))
@long-calculation
```

Future & Delay in ending program

When you end your program there will be a 1 minute delay if you used future

End your program with (shutdown-agents)

```
(def long-calculation (future (apply + (range 1e8))))

@long-calculation

(shutdown-agents)
```

(shutdown-agents) & REPL

(shutdown-agents) shuts down your REPL

deref with Timeout

```
(deref (future (Thread/sleep 5000) :done!)
       1000
       :impatient!)
  ;= :impatient!
```

Future & Zipper Example

Count the number of items in RSS feed with given title

Get RSS xml from server
Parse the XML
Get the title of each article in the feed
Match titles of articles with title looking for
Count the matches

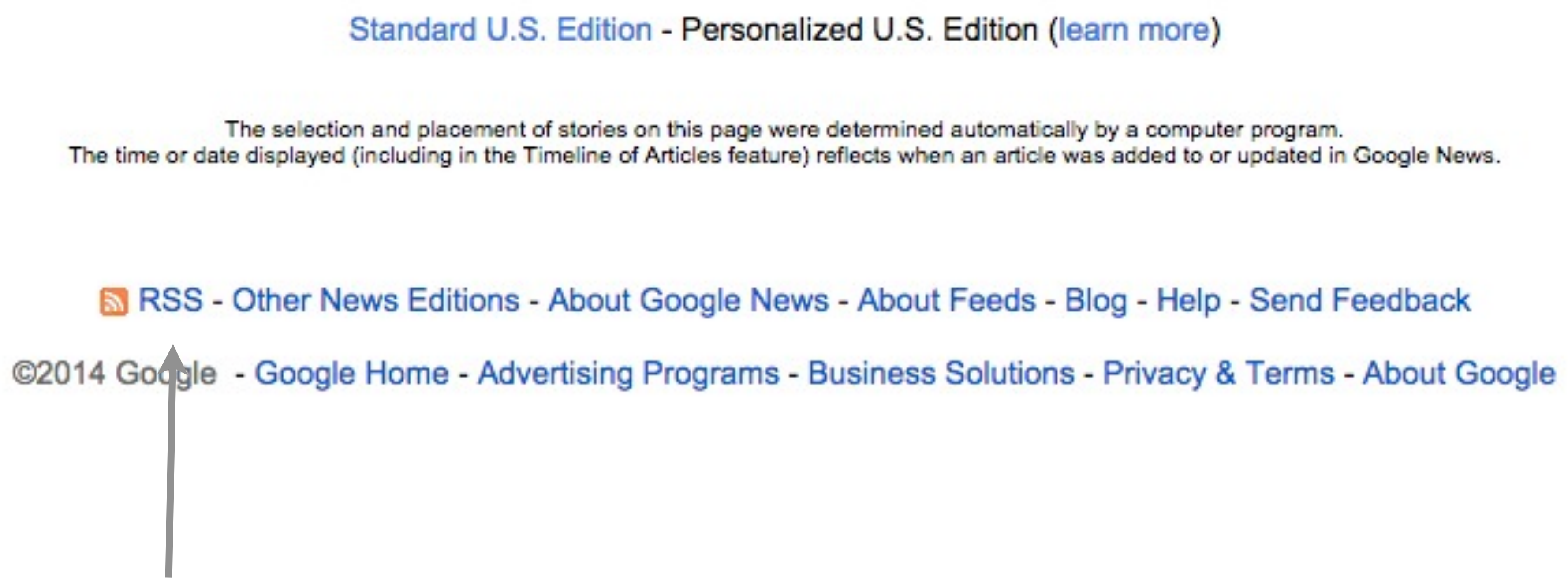
Example taken from "The Joy of Clojure", Second Edition, Chapter 11

RSS

Rich Site Summary
Really Simple Syndication

XML document

Contains meta-data & content of website
- blogs
- news sites


Standard U.S. Edition - Personalized U.S. Edition (learn more)

The selection and placement of stories on this page were determined automatically by a computer program.
The time or date displayed (including in the Timeline of Articles feature) reflects when an article was added to or updated in Google News.

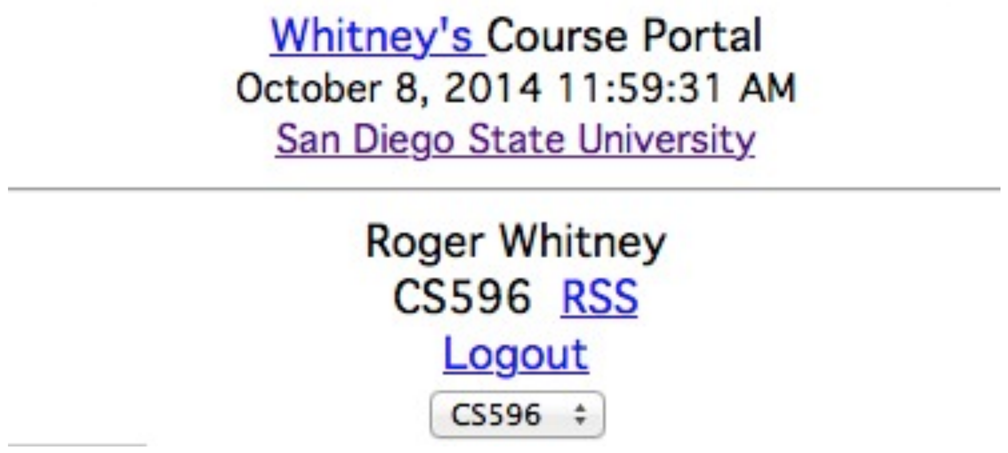
RSS - Other News Editions - About Google News - About Feeds - Blog - Help - Send Feedback

©2014 Google - Google Home - Advertising Programs - Business Solutions - Privacy & Terms - About Google

RSS feed Content

```
<?xml version="1.0" encoding="UTF-8" ?>
<rss version="2.0">
<channel>
 <title>RSS Title</title>
 <description>This is an example of an RSS feed</description>
 <link>http://www.example.com/main.html</link>
 <lastBuildDate>Mon, 06 Sep 2010 00:01:00 +0000 </lastBuildDate>
 <pubDate>Sun, 06 Sep 2009 16:20:00 +0000</pubDate>
 <ttl>1800</ttl>

 <item>
  <title>Example entry</title>
  <description>Here is some text containing an interesting description.</description>
  <link>http://www.example.com/blog/post/1</link>
  <guid>7bd204c6-1655-4c27-aeee-53f933c5395f</guid>
  <pubDate>Sun, 06 Sep 2009 16:20:00 +0000</pubDate>
 </item>
</channel>
</rss>
```


Whitney's Course Portal
October 8, 2014 11:59:31 AM
San Diego State University

Roger Whitney
CS596 RSS
Logout

http://bismarck.sdsu.edu/CoursePortalFeed.rss?class=cs596

```
<?xml version="1.0" encoding="utf-8"?>
<rss version="2.0" xmlns:content="http://purl.org/rss/1.0/modules/content/"
xmlns:wfw="http://wellformedweb.org/CommentAPI/" xmlns:dc="http://purl.org/dc/
elements/1.1/">
<channel>
    <title>CS596 Course Portal RSS feed</title>
    <link>http://bismarck.sdsu.edu/CoursePortal</link>
    <description>Changes and additions to the Course Portal</description>
    <item>
        <title>Grades</title>
        <description>Grades posted</description><pubDate>Wed, 01 Oct 2014 20:06:33
        +0000</pubDate>
        <link>http://bismarck.sdsu.edu/CoursePortal</link>
        <guid>http://bismarck.sdsu.edu/CoursePortal?news=4471</guid>
    </item>
</channel>
</rss>
```

clojure.xml/parse

(parse s)

Parses and load source s

Source - File, InputStream, URI string

Returns tree of xml/element struct-map

```
(clojure.xml/parse "http://bismarck.sdsu.edu/CoursePortalFeed.rss?class=cs596")
```

```
{:tag :rss, :attrs
{:version "2.0", :xmlns:content "http://purl.org/rss/1.0/modules/
content/", :xmlns:wfw "http://wellformedweb.org/
CommentAPI/", :xmlns:dc "http://purl.org/dc/elements/1.1/"},
:content [{:tag :channel, :attrs nil, :content [{:tag :title, :attrs nil, :content
["CS596 Course Portal RSS feed"]} {:tag :link, :attrs nil, :content ["http://
bismarck.sdsu.edu/CoursePortal"]} {:tag :description, :attrs nil, :content
["Changes and additions to the Course Portal"]} {:tag :item, :attrs
nil, :content [{:tag :title, :attrs nil, :content ["Grades"]}
{:tag :description, :attrs nil, :content ["Grades posted"]}
{:tag :pubDate, :attrs nil, :content ["Wed, 01 Oct 2014 20:06:33 +0000"]}
{:tag :link, :attrs nil, :content ["http://bismarck.sdsu.edu/CoursePortal"]}
{:tag :guid, :attrs nil, :content ["http://bismarck.sdsu.edu/CoursePortal?
news=4471"]}]}]}]}
```

Using a Zipper

```
(ns basiclectures.basic-language.feed-example
  (:require (clojure [xml :as xml]))
  (:require (clojure [zip :as zip])))

(defn feed->zipper
  [uri-str]
  (->> (xml/parse uri-str)
          zip/xml-zip))



(feed->zipper "http://bismarck.sdsu.edu/CoursePortalFeed.rss?class=cs596")
```

```
[{:tag :rss, :attrs {:version "2.0", :xmlns:content "http://purl.org/rss/1.0/modules/
content/", :xmlns:wfw "http://wellformedweb.org/CommentAPI/", :xmlns:dc
"http://purl.org/dc/elements/1.1/"}, :content [{:tag :channel, :attrs nil, :content
[{:tag :title, :attrs nil, :content ["CS596 Course Portal RSS feed"]}
{:tag :link, :attrs nil, :content ["http://bismarck.sdsu.edu/CoursePortal"]}
{:tag :description, :attrs nil, :content ["Changes and additions to the Course
Portal"]} {:tag :item, :attrs nil, :content [{:tag :title, :attrs nil, :content ["Grades"]}
{:tag :description, :attrs nil, :content ["Grades posted"]} {:tag :pubDate, :attrs
```

RSS verses Atom

RSS 2.0		Atom
channel	Top level tag	feed
item	Tag for article	entry
title	Tag for article title	title
Has one more nesting level		

There are other differences but these are the ones that will affect us now

Normalizing both to Common structure

```
(ns basiclectures.basic-language.feed-example
  (:require (clojure [xml :as xml]))
  (:require (clojure [zip :as zip])))


 (defn is-atom?
   [feed]
   (= :feed (:tag (first feed))))

 (defn normalize
   [feed]
   (if (is-atom? feed)
     feed
     (zip/down feed)))
```

Getting all Articles from a Feed

```
(ns basiclectures.basic-language.feed-example
  (:require (clojure [xml :as xml]))
  (:require (clojure [zip :as zip])))


(defn feed-children
  [uri-str]
  (->> uri-str
       feed->zipper
       normalize
       zip/children
       (filter (comp #{:item :entry} :tag))))
```

Example

```
(feed-children "http://bismarck.sdsu.edu/CoursePortalFeed.rss?class=cs596")
```

```
({:tag :item, :attrs nil,
:content [{:tag :title, :attrs nil,
    :content ["Grades"]}
    {:tag :description, :attrs nil, :content ["Grades posted"]}
    {:tag :pubDate, :attrs nil, :content ["Wed, 01 Oct 2014 20:06:33 +0000"]}
    {:tag :link, :attrs nil, :content ["http://bismarck.sdsu.edu/CoursePortal"]}
    {:tag :guid, :attrs nil, :content ["http://bismarck.sdsu.edu/CoursePortal?news=4471"]}]})
```

Getting the title of single article

```
(defn title
  [entry]
  (some->> entry
         :content
         (some #(when (= :title (:tag %)) %))
         :content
         first))
```

```
{:tag :item, :attrs nil,
:content [
    {:tag :title, :attrs nil, :content ["Grades"]}
    {:tag :description, :attrs nil, :content ["Grades posted"]}
    {:tag :pubDate, :attrs nil, :content ["Wed, 01 Oct 2014 20:06:33 +0000"]}
    {:tag :link, :attrs nil, :content ["http://bismarck.sdsu.edu/CoursePortal"]}
    {:tag :guid, :attrs nil, :content ["http://bismarck.sdsu.edu/CoursePortal?news=4471"]}]}
```

string-contains

```
(defn string-contains
  [string pattern]
  (let [lower-case-string (.toLowerCase string)
        lower-case-pattern (.toLowerCase pattern)
        index (.indexOf lower-case-string lower-case-pattern)]
    (> index -1 )))
```

Counting the matching articles

```
(defn count-text-task
  [extractor text feed]
  (->> (feed-children feed)
         (map extractor)
         (filter #(string-contains % text))
          count))

(def count-title-task (partial count-text-task title))



(count-title-task "Grade"
                        "http://bismarck.sdsu.edu/CoursePortalFeed.rss?class=cs596")
```

Ebola news

```
(count-title-task
    "Ebola"
    "http://news.google.com/news?pz=1&cf=all&ned=us&hl=en&output=rss")
```

But there are a lot of different news feeds

Using future to fetch in parallel

```
(def news-feeds
      #{"http://news.yahoo.com/rss/"
        "http://feeds.nbcnews.com/feeds/worldnews"
        "http://news.google.com/news?pz=1&cf=all&ned=us&hl=en&output=rss"})

(let [results (for [feed news-feeds]
                (future (count-title-task "Ebola" feed)))]
  (reduce + (map deref results)))
```

```
19
```

Complete Example

```clojure
(ns basiclectures.basic-language.feed-example
  (:require (clojure [xml :as xml]))
  (:require (clojure [zip :as zip])))

(defn feed->zipper
  [uri-str]
  (->> (xml/parse uri-str)
       zip/xml-zip))

(defn is-atom?
  [feed]
  (= :feed (:tag (first feed))))

(defn normalize
  [feed]
  (if (is-atom? feed)
    feed
    (zip/down feed)))

(defn feed-children
  [uri-str]
  (->> uri-str
       feed->zipper
       normalize
       zip/children
       (filter (comp #{:item :entry} :tag))))

(defn title
  [entry]
  (some->> entry
           :content
           (some #(when (= :title (:tag %)) %))
           :content
           first))
```

```clojure
(defn string-contains
  [string pattern]
  (let [lower-case-string (.toLowerCase string)
        lower-case-pattern (.toLowerCase pattern)
        index (.indexOf lower-case-string lower-case-pattern)]
    (> index -1 )))

(defn count-text-task
  [extractor text feed]
  (->> (feed-children feed)
       (map extractor)
       (filter #(string-contains % text))
       count))

(def count-title-task (partial count-text-task title))

(def news-feeds #{"http://news.yahoo.com/rss/"
                  "http://feeds.nbcnews.com/feeds/worldnews"
                  "http://news.google.com/news?pz=1&cf=all&ned=us&hl=en&output=rss"})

(let [results (for [feed news-feeds]
                (future (count-title-task "Ebola" feed)))]
  (reduce + (map deref results)))
```